Measurements with a Greenspan Acoustic Viscometer

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We developed a double Helmholtz acoustic resonator (Greenspan viscometer) to measure the viscosity of gases at temperatures from 250 K to 400 K and at pressures up to 3.2 MPa. In anticipation of working with corrosive gases, the inner surfaces of the resonator and of the manifold were made entirely of metal. Care was taken to eliminate systematic errors caused by oscillations of the apparatus that might broaden the width of the Helmholtz resonance. The resonator features a vibration damping suspension, and it is filled from a tube that is connected to the center of the resonator's duct. The connection is at a point of symmetry to reduce the acoustic coupling between the Helmholtz resonance and the resonances of the gas in the manifold.

The data determine both the viscosity and the speed of sound of the test gas. The latter is useful for verifying the purity or, in the case of mixtures, the composition of the test gases. The viscometer and the acoustic model were tested using gases with known viscosities. Measurements were carried out on argon and helium at 298.15 K and 348.15 K at pressures up to 3.2 MPa. Propane was studied at 298.15 K at pressures up to 0.8 MPa. The deviations of the experimental results from the literature data ranged from -1.2 % to -0.2 % of the viscosity and from 0.1 % to 0.2 % of the speed of sound. After calibration of the viscometer, the measurements were characterized by uncertainties of ±0.4 % for the viscosity and ±0.05 % for the speed of sound.

As part of a project to study working fluids for thermoacoustic refrigerators, the new instrument was used to measure the viscosities of three different helium-xenon mixtures in the temperature range from 250 K to 360 K and pressures up to 1.8 MPa.

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